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Ethyl Chloride

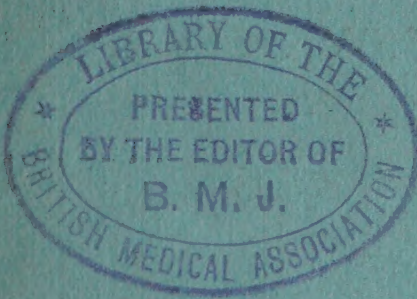
Its Scope and Methods of Administration
as a General Anaesthetic

BY

CHARLES T. W. HIRSCH,

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*Lecturer and Anæsthetist, University College Hospital Dental School ;
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London Temperance, Grosvenor, Metropolitan Throat & Epileptic Hospitals.*



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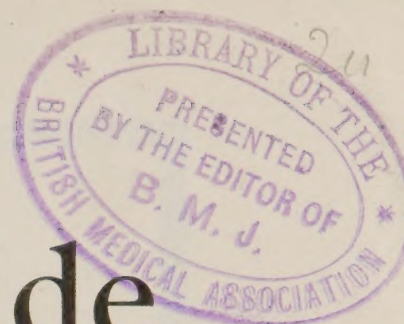
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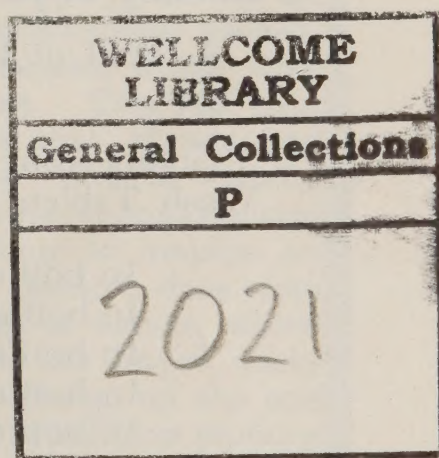
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FOREWORD

SIR ALFRED MOND said recently: "There are people who say 'NO' to every new idea, simply because it is new; such people hold back the progress of industries." This remark can be applied to anæsthetics, especially ethyl chloride, in its early days, as well as now. It was, I admit, introduced by Lotheisen as far back as 1895. In 1903 McCardie, of Birmingham, strongly advocated its value as an anæsthetic. Interest then, as well as now, did attach itself to any new anæsthetic. There was always the hope that some new planet might swim within our ken. Often such a comet turns out to be but a spark from a burning rubbish heap. Some incorrectly thought, and even now think so regarding ethyl chloride. The thorns that did bestrew the path of this drug thickly in its early days seem, wrongly, I again maintain, still to hamper its career. Experts used it, and were most enthusiastic. Napoleon was wise in his aphorism, "Point de Zele." The eulogy of its early advocates led to its employment by all and sundry; many without knowledge of the technique needed. Thus these discovered many doubtful qualities, which they unjustly aggravated into veritable dangers. This has been the position of ethyl chloride. I admit that change and improvement are not always synonymous. Still, as Voltaire remarks: "The weathercock that always points in one direction is apt to become rusty." Without wishing to employ an impolite metaphor, the bag of anæsthetic research does often contain some valuable and glowing piece of colour, which contrasts to no disadvantage with much of our frayed, dusty odds and ends of old-fashioned ways, especially, on the one hand, such as rely on cyanosis and nitrous oxide to produce unconsciousness, or to go right to the other end of the pendulum swing, to-day's explosive smelling gases, ethylene and acetylene.

The cardinal reason for the issue of this little work is to present the old phenomena, as well as the more modern, of the uses of ethyl chloride in a fair way, to throw open widely the doors of this anæsthetic house, casting illuminating beams on its most private interior, but not shutting our eyes from honest scrutiny even if our pen is loosened for laudation. Thus we may gauge its value as a weapon in our armoury.

Bearing in mind that: "Belief may be easier, though certainly not as advantageous as investigation. . ." there is, for those who seek it, an easy path through the anæsthetic jungle, where dread spectres of sudden death do not lurk. This anæsthetic certainly can be said to have passed through the fire of use, and has come out, if not pure gold, still an anæsthetic of great value for short operations, and to establish anæsthesia quickly, prior to employing ether or chloroform.

The burning of our anæsthetic family boats does not always mean that the new boats we will be under the necessity of building will be more seaworthy than the old. The outcome of my own practical experience, however, convinces me that ethyl chloride is, subject to the acquisition of the technique of its administration, a valuable addition to our armamentarium.

If the few scattered threads I have here drawn together prove of value in helping colleagues to come to such a decision, I shall feel that I have not journeyed on the road in vain, nor fruitlessly spilt much ink. In conclusion, I desire to express my grateful thanks to Messrs. Coxeter, Messrs. Bengué and other firms for permission to use blocks in their possession for the illustrations.

CHARLES T. W. HIRSCH.

*Old Park House,
Ifield, Sussex.*

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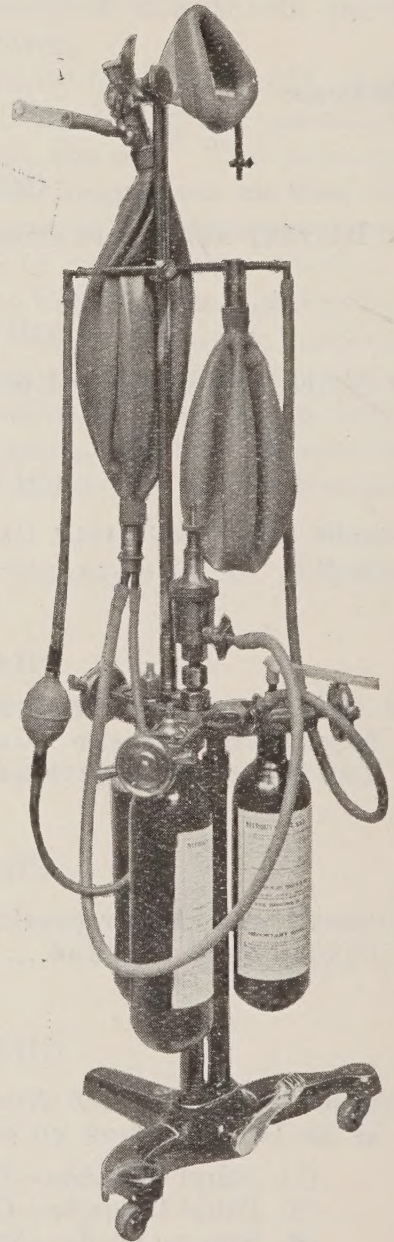
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ETHYL CHLORIDE

Its Scope and Methods of Administration as a General Anaesthetic

CHAPTER I

THE HISTORY AND PROPERTIES OF ETHYL CHLORIDE

ETHYL CHLORIDE dates back to 1848, when it was employed by Heyfelder. It receives mention in Benjamin Ward Richardson's "Synopsis of Anæsthesia," which was published in 1885. In the early days the fair reputation it was said, and rightly said, to possess, was marred by an adverse report of the Glasgow Committee of the British Medical Association, published in 1880, and by accounts of cases of collapse, or sudden death, then stated to have occurred. The then disrepute was partly due to the impurity of the samples used, and also probably to want of correct knowledge of how to administer it. Fatalities are not always the consequence of the anæsthetic; the fault may sometimes be laid at the door of the administrator. Frequently status lymphaticus gets the credit. Unjustly I suggest. I cannot help thinking that, if the very late lamented King Herod came back to earth and this time ordered the execution of all the five-year-olds, a persistent thymus would be found in most; also if any or all were anæsthetized correctly, that fatalities would be conspicuous by their absence. But to return to the subject of this chapter, Lotheisen should be credited with its reintroduction in 1896, McCardie, of Birmingham, followed his example, and in 1903 published an article advocating its employment. As a consequence it was tried by all and sundry. The results obtained by different administrators, as could be anticipated, varied greatly. More, as already suggested, from lack of skill in its use, than to lack of suitability of the drug. To-day, though not as popular as I venture to assert it should be, it has its

vogue, and is much employed for short operations, especially for tonsil and dental cases. In many school clinics it is the routine anæsthetic employed. At many throat hospitals it is likewise the usual anæsthetic in the out-patient department for tonsil operations. This would not be the case if casualties were frequent.

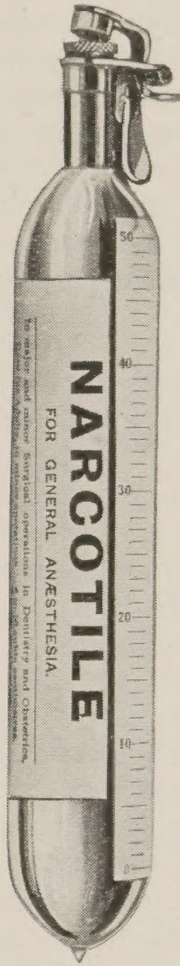
Ethyl chloride at ordinary temperature is a gas, when slightly compressed it is a colourless, mobile liquid with an ethereal odour. It is made by passing dried hydrochloric acid into a flask containing absolute alcohol and powdered anhydrous zinc chloride. The zinc chloride is a dehydrating agent and takes up the water evolved during the reaction. The ethyl chloride gas given off is then passed through a condenser, purified by passage through wash bottles, and finally collected in U tubes immersed in a freezing mixture. It is important that pure ethylic alcohol be used; if methylated is employed methyl chloride and other impurities may be present.

Its specific gravity is 0.921. It is very volatile, boiling at 12.5°C . At 37°C . the blood absorbs over 500 per cent. of the vapour by volume. It also gives it up equally rapidly. Thus the ease of administering an overdose, also the cause of the rapid recovery of the patient after the cessation of its administration. It, however, carries a marked period of analgesia in its train. This, as will be subsequently pointed out, does enable manipulations to be continued, when the patient is apparently coming to, without any recollection on the patient's part after consciousness is regained. König in experiments on animals found that 10 per cent. of the vapour took six minutes to produce anæsthesia, while with 50 per cent. it came on under one minute. The late Sir Frederick Hewett conducted a series of investigations with various percentages: 9, 3, 11, 9 and 12 respectively, without rebreathing, using a valved stopcock; the results were not satisfactory, nor when one half of the mixture was breathed by the valvular system and the other half by the closed system. He concluded that the continuous inhalation of ethyl chloride and air without rebreathing did produce effects of an inconvenient type, such as shallow breathing and swallowing. With a 3-gallon bag and using a Clover inhaler, with 5 c.c. of the drug and rebreathing as soon as the patient became accustomed to the taste, discomfort to the patient was absent and a good anæsthesia was obtained in some two minutes or less. Yandell Henderson of course would declare that what was needed was the respiratory stimulation of carbon dioxide obtained by re-breathing. Acting on his suggestion the writer gave some dozen cases ethyl chloride, using a 2-gallon bag containing oxygen plus 20

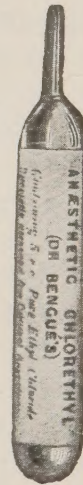
per cent. carbon dioxide ; the results were certainly satisfactory, and will be again referred to at greater length in Chapter IV.

It certainly is like nitrous oxide in the rapidity with which it abolishes consciousness, especially when partial air limitation is employed. It is also like chloroform in that an over-

BENGUÉ'S ETHYL CHLORIDE IN GRADUATED GLASS TUBES AND SEALED BULBS FOR GENERAL ANÆSTHESIA.



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Pure ethyl chloride for general anæsthesia. 3-c.c. and 5-c.c. sealed bulbs (twelve bulbs in each box).

dose, which of course can always be avoided, may produce a fatality. Our problem to consider when later on discussing methods of administration will be how to give it so that its great advantages are secured, while its disadvantages are avoided. With correct technique this can always be done.

After all, the administration of every anæsthetic is not a matter to be lightly undertaken, but given by experienced medical men, who have taken the trouble to learn how to do it, ethyl chloride will be found a most useful and valuable agent.

As regards its physiological action, it augments respiration, and at first lowers and then increases the pulse-rate. The question of the effect on blood-pressure has been the subject of dispute, the general opinion seems to incline to the conclusion that it produces a lowering, probably the result of the dilatation of the peripheral vessels, which is always associated with its inhalation. It is stated not to affect the urinary secretion. In experiments on animals it was found that to stop the heart it had to be presented about nineteen times more concentrated than chloroform.

It is supplied in small 3-c.c. or 5-c.c. tubes, or in graduated 50 c.c. tubes with an automatic valve stopper, such as illustrated, likewise in metal cylinders containing up to 250 gm.

CHAPTER II

THE SCOPE AND USES OF ETHYL CHLORIDE

ETHYL CHLORIDE may be used as a general anæsthetic in three different ways. Its commonest employment is like nitrous oxide, that is, to produce anæsthesia of short duration for slight, rapid operations, dental extractions, tonsillotomy, probing the lachrymal cyst in children, &c. Secondly, again like nitrous oxide, to induce anæsthesia quickly, preparatory to carrying on with ether or chloroform. Thirdly, for maintaining anæsthesia for longer periods without the use of any other anæsthetic. Its portability, the rapidity of its action, and the length of time it permits for operative procedures makes it compare well with nitrous oxide for practically all short operations. For children its great value is the shortness of the induction period, generally 50 to 100 seconds. With the closed method it may be even less. As to that most important question, its safety, Dr. Webster, of Winnipeg, Canada, reports 22,000 administrations without a casualty. Hornabrook, of Melbourne, has 43,433 cases to his credit, all without accident. Dr. Webster's cases were given either by himself or skilled assistants. Dr. Hornabrook, however, states that many of his were given by men with only slight experience of anæsthetics. If the report of failures is also of educational value, probably it is of more use than even the brilliant successes just given; we can turn to McCardie's report of 12,000 cases in Birmingham, in which he gives the occurrence of four deaths. Lee reports 5,575 cases with five deaths, but these were all bad risks. It therefore seems that the question of safety is not so difficult to estimate, and that now with full knowledge of the technique, and what is most important a pure drug, and proper preparation of the patient, it can be regarded as safe. Of course, all anæsthetics are poisonous, otherwise they would scarcely render the patient unconscious, and an overdose of any poison is, of course, dangerous. The safety, I take it, of every drug used to produce unconsciousness depends not so much on whether an overdose will kill, as on whether it is likely to do so suddenly without giving a watching, careful anæsthetist warning of the

approach of danger. With ethyl chloride the signs of danger are not likely to be missed by a competent observer; I therefore feel that I can claim it as a safe anæsthetic. As to its employment for prolonged anæsthesia I do not think that it is as easy to administer, or that I would advocate it for general employment, though, as will be dealt with in Chapter V, it can be so used.

It is a great thing in this world to realize one's limitations; the same can be said of anæsthetic drugs.

CHAPTER III

SUITABLE AND UNSUITABLE CASES—
PRE-ANÆSTHETIC PREPARATION

A most important function of the speciality is the selection, not only of the best anæsthetic but likewise of the most desirable method of giving it for each individual case. It comes to this, that the choice should be for that drug and way of giving it which is : (1) Safest for the patient ; (2) adequate for the surgeon's manipulation, and (3) not unacceptable to the patient. It is not always easy to make these three essentials coincide.

Ethyl chloride, as we have already stated, is, IF PROPERLY GIVEN AND BY AN OBSERVANT ANÆSTHÉTIST, safe. For short operations it fulfils all the requirements of the surgeon, and for those throat operators who are used to its employment, it answers their needs for prolonged operations.

Surgeons differ in their ideas as to whether a case is or is not adequately anæsthetized for the surgical procedure they have to carry out. The essential point is certainly that the surgeon and anæsthetist should work together. It is also essential that the patient should be rendered unconscious, and, where needed, so slack that the operator can perform his task. My own experience is that surgeons, if treated with these needs fulfilled, are most pleasant colleagues to work with and always agreeable to fall in with any suggestion of the anæsthetist which may add to the safety of the patient and assist his labour. Who can blame them if they are contrary if their needs are not attended to? It is said that some are prone to be so. Still, the anæsthetists must also have regard to the patient's safety. Ethyl chloride is suitable and more ideal for all short operations or manipulations needing two to five minutes' anæsthesia. It is not certain to produce complete muscular relaxation, so by itself it is not suitable for abdominal operations.

On account of its rapidity in action it is the ideal anæsthetic for children and nervous patients, anyway as an introduction to either ether or chloroform. With it the patient is generally

unconscious after three or four breaths, thus curtailing an extremely distressing and uncomfortable period, especially for highly-strung nervous subjects.

As with all anæsthetics, the evaluation of the risks should first be estimated. Ill or handicapped patients do need medical appraisal prior to operation. Pre-operative preparation and treatment do ensure greater safety. Tests based on blood-pressures, on the effects of thirty seconds' inspiration, on the systolic readings, breath-holding tests, the effect of exercise on pulse-rate, all are valuable aids in deciding on the efficiency of the circulation, and to put the supposedly fit into their true pigeon holes. The cardiac cripple can be made a better subject for an anæsthetic by prolonged rest, coupled with the administration of digitalis; the hyperthyroid with rest and iodine; the diabetic with rest and insulin; the toxæmic with preliminary glucose and also perhaps insulin. In what cases should ethyl chloride be avoided? Serious albuminuria, glycosuria, uncompensated cardiac disease, large pleural effusions, cases of tubercle, and any likely to show obstruction to the air passages are not suitable. As regards the type of patient, strong, muscular men with powerful teeth and jaws are likely to prove difficult subjects. Neurotics, alcoholics and heavy smokers may also give trouble. This is so, however, whatever anæsthetic is given.

In spite of the remarks as to cases likely to show air-passage obstruction being unsuitable, it is, as already stated, the ideal anæsthetic for the removal of tonsils and adenoids in children, especially when the O'Malley enucleation operation is employed for the former. For dissection it may not give for all operators a sufficiently long anæsthesia, unless the prolonged method of administration, such as will be dealt with in Chapter V, is employed.

It is also most useful for ophthalmic operations, such as needling or lachrymal duct probing in very young children, and even babies. For the latter the open administration is the most suitable.

The preliminary preparation should be the same as that for chloroform or ether. Where possible the bowels should be cleared out by medicine given on the second night before the anæsthetic. The usual enema on the day of operation need not be insisted upon. If it is used, there is no need to arouse the patient for it at an unearthly hour, as long as it is given so that it has concluded acting some time prior to the operation. The last meal should be taken not later than five hours before the operation. The meal should consist of soup, free from fat, broth or bovril. A little glucose can be given on the previous

night, say half an ounce, also in the morning. Milk is not desirable. To prevent salivation, where possible a preliminary hypodermic of atropine, one hundredth of a grain, may be administered twenty minutes previous to the operation.

It is not essential for the usual short dental and tonsil cases.

It is as well to empty the bladder prior to the administration ; involuntary evacuation during anæsthesia may otherwise occur.

All constrictions about the neck and waist should be removed, and, what is most important, the patient's position must be such as will favour a free air way, and perfect lung ventilation.

Any posture can, unless the patient is very asthenic, be adopted, that is, either the sitting or reclining. The former is most suitable for dental cases and, subject to the head being correctly placed, much favoured by many throat specialists for tonsil and adenoid operations.

CHAPTER IV

THE ADMINISTRATION BY THE OPEN AND
CLOSED METHODS. ARGUMENTS FOR
AND AGAINST EACH TYPE OF INDUC-
TION. THE SIGNS OF ANÆSTHESIA

ETHYL CHLORIDE is very volatile, it boils at 12.5°C ., and at 37°C . the blood absorbs over 500 per cent. of the vapour by volume. It also gives it up equally rapidly. The reason of again remarking on these physical properties is the indication they give as to the method of administration. Our problem is of course to use the drug in such a way that its advantages are secured while its disadvantages are avoided. The effects produced depend chiefly upon its vapour tension in the atmosphere presented to the patient, and a partially closed method of administration is therefore indicated. Still I wish to emphasize the word partially, and not to urge that a closed method is absolutely essential. Does the way of giving it make a difference as regards safety? The advocates of each rather claim an anæsthetic Utopia for their favourite and incidentally criticize the one they depreciate. Their praises of the merit of one is at the same time an indictment of the other. Our first and chief object is of course the safety of the patient. The present knowledge of ethyl chloride should make us recognize that, irrespective of the method employed for administration, it is safe in the hands of the experienced, and that there is no need to conjure up the dread spectre of sudden death to scare the anæsthetist, if he will learn how to use it, and the indications pointing to possible danger.

It will be well now to have a full dress debate on the two methods, and to describe the different techniques, without any bias in favour of any one.

The closed method naturally involves the use of some form of inhaler. Of these their number is legion. Much ingenuity has been expended in devising them and doubtlessly they all possess some merit to add fame to the introducer, and when the method of employing it is acquired, ease of mind to the user and, of course, safety to the patient and satisfaction to the surgeon.

The essentials are an accurately fitting facepiece, connected by capacious channels with a rubber bag of sufficient size to

contain some six expirations of an ordinary adult. Some form of stopcock must be fitted, so that air can be admitted direct, and at will, to and fro bag breathing. Some method must also be provided to introduce the ethyl chloride into the bag. A primitive method is to drop in the bag one or two ethyl chloride sealed tubes, each containing 2 to 5 c.c. After the patient has become accustomed to the facepiece, has filled the bag with expirations, then to and fro re-breathing is started, an ethyl chloride tube being broken, by catching hold of it from the outside of the bag. This is not exactly conducive to the health of the bag fabric, though certainly to that of the rubber industry. So a ball-valve guarded port is fitted to some bags, and thus, using a graduated tube, the needed quantity can be squirted in. The two essentials for all apparatus designed for the purpose, are the absence of obstructions to free re-breathing, that is wide bore breathing channels, and a bag of sufficient capacity. Though re-breathing is the method, avoidance of undue air deprivation is essential.

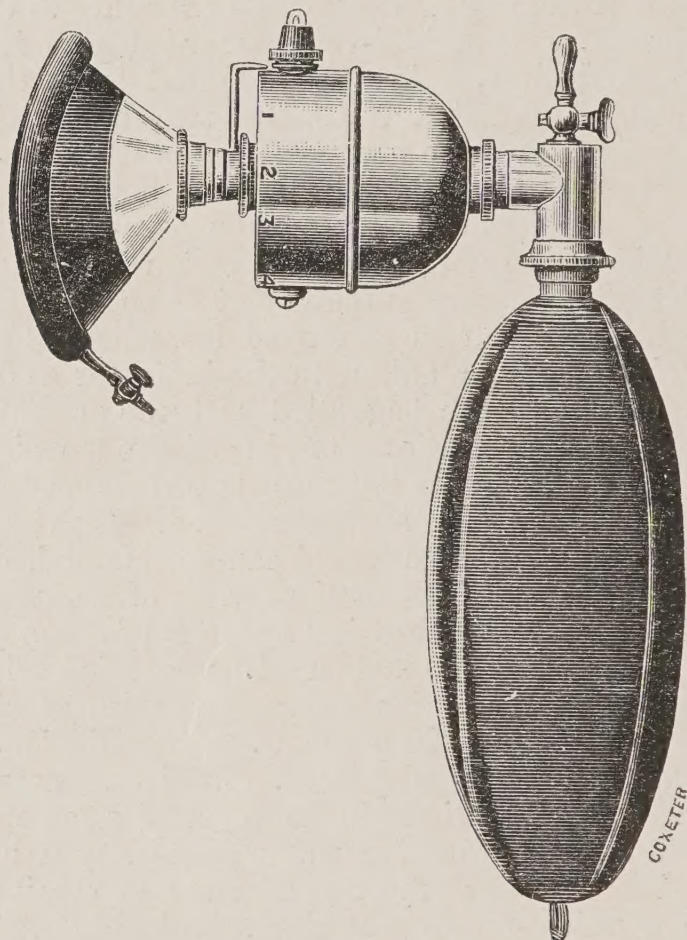
McCardie advocates the employment of an ordinary Clover wide bore inhaler such as employed for ether: 3 to 5 c.c. is placed in the container and with the indicator at 0 the facepiece is applied and the bag filled with the patient's expirations, catching the expirations, but lifting the facepiece during the inspirations. Then the indicator is turned gradually on to full, to and fro breathing being commenced. If the anæsthetic is turned on gradually, anæsthesia can be established quickly, without discomfort to the patient and of course without cyanosis, any sign of which being a demand for the admission of a little air. The bag, in lieu of being filled with expirations, can be charged with oxygen or with a mixture of 80 per cent. oxygen and 20 per cent. carbon dioxide. This is what Yandell Henderson advocates. Twelve cases were thus anæsthetized by the writer, including adults, alcoholics and smokers; in ten the induction was without any struggling, in two (retired stout police officers, and one had attained to the position of a public-house manager), struggling was marked. In all the anæsthesia obtained was satisfactory. In three cases it was used as an introduction to ether.

The mount by which some bags are attached to the Clover inhaler is sometimes fitted with a tap or ball-guarded valve for the introduction of ethyl chloride. If this way of introducing the ethyl chloride is fitted the reservoir on the Clover can be charged with ether, and should it be desired the anæsthesia can be supplemented or continued with ether.

Another method is to fit the bag directly to the Clover inhaler by an angle piece, spraying firstly the ethyl chloride

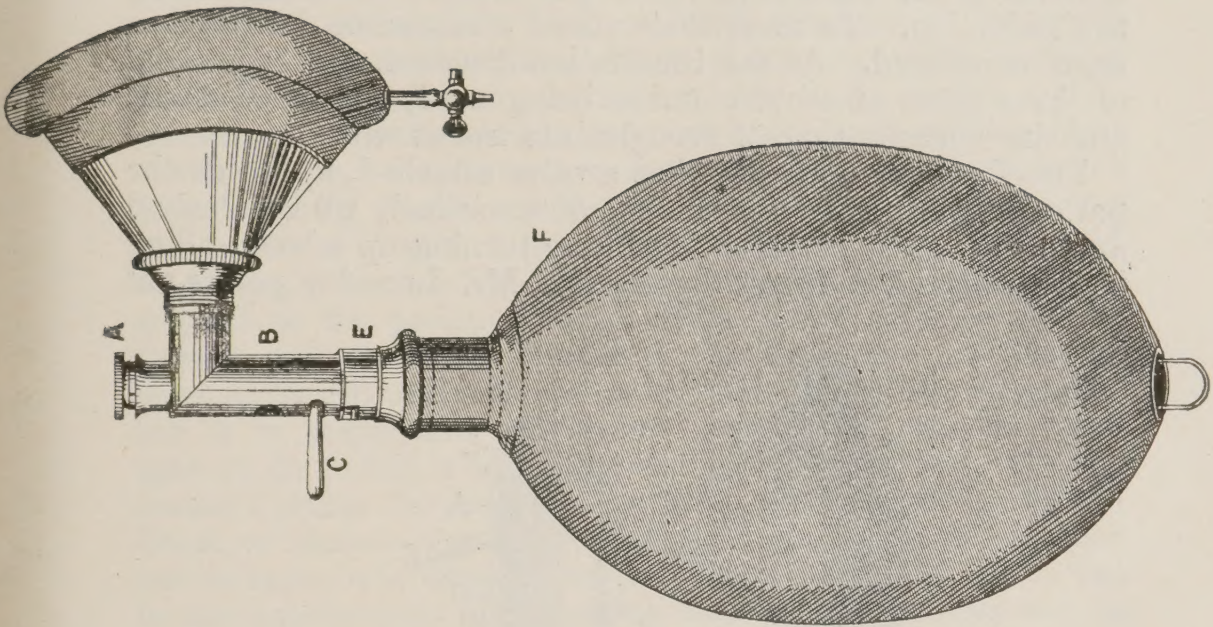
into the bag, then by catching expirations fill the bag, and when it is full re-breathing. An Ormsby inhaler with the sponge removed can likewise be employed, the face-piece being well suited as it has a slot to permit of drawing in air at the beginning for the bag inflation. It can be closed during re-breathing, and slightly opened during inspiration, when a little air is required.

A simple form of apparatus is sold by Messrs. Bengué. Its construction will be understood by the illustration.

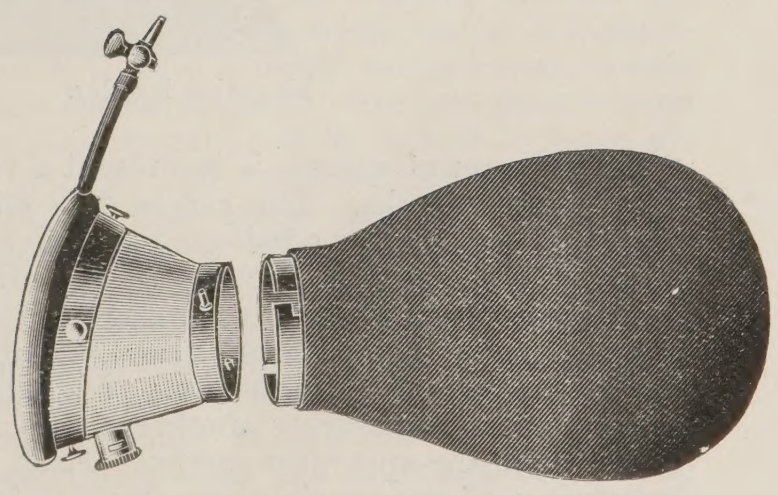


Clover inhaler with ethyl chloride attachment.

The metal cap A forms a stopper at the top of the elbow B, and into this space a sealed tube of ethyl chloride can be inserted. The lever C, which is opened prior to the insertion of the anæsthetic tube, also permits the patient to breathe in air. In use, after application of the face-piece, it is closed temporarily by the finger, and the patient is told to inflate the bag, then the lever C is used, closing the air inlet and breaking the ethyl chloride tube, and re-breathing



Bengué's ethyl chloride inhaler.

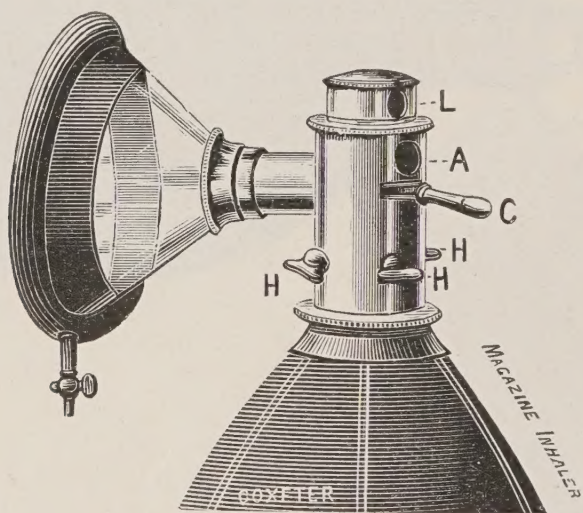


Ormsby inhaler.

proceeded with, the liquid spreading into the apparatus and becoming mixed with the respiratory air. The ethyl chloride can also be squirted in directly through the port, controlled by the lever C.

Some anæsthetists prefer not to introduce all the ethyl chloride at the beginning, but to put more into the bag during the induction. To meet their views a magazine inhaler has been introduced. As the illustration demonstrates, it permits of three tubes of ethyl chloride being used, and any broken, and the contents thereof brought into use at will.

The Looseley apparatus has a valve attached, by which the patient's own breath fills the bag automatically till the desired amount of air is obtained, when, by turning up a lever, filling is stopped and re-breathing starts. Mr. Looseley points out



Magazine inhaler.

that the secret of success is to present a very weak vapour for the first few breaths. This can be done with his apparatus or with any that possess a ball-guarded valve for introducing the anæsthetic by putting 1 or 2 c.c. into the bag at first and then gradually adding more till the desired effect is attained, care of course being taken to only add the ethyl chloride during the patient's expirations. With the magazine inhaler this is done by fracturing another of the three ethyl chloride bulbs which the apparatus carries. Each is separately broken by turning off the special taps provided for that purpose. A perforated tray in the bag mount is provided to catch the broken glass. A similar result is obtained with the Clover apparatus, when the ethyl chloride is placed in the container, by progressively turning on from zero to four or full amount.

A reversible rubber bag can be had, which enables cleansing after each case, and does away with one of the great objections to the closed method. Among other inhalers may be mentioned the Simplex designed by Dr. Luke of Edinburgh, and Dr. Beresford Kingsford's modification of Mr. Boyle's wide-bore inhaler---this has lint lining the inside of the mask.

Many of the inhalers have celluloid face-pieces fitted with detachable pneumatic pads. They, of course, permit of seeing the face during the administration, but such should not be necessary. The detachable pads are apt to leak, and the edges of the celluloid may press unpleasantly hard on the patient's face. Messrs. Barth and Messrs. Coxeter both manufacture face-pieces of a sort of poroplastic material with fixed pneumatic pads, that adapt themselves easily and without discomfort to the patient's face. Those made now by Messrs. Coxeter will stand sterilization by boiling water. As success depends largely upon the accuracy with which the face-piece fits it is important to employ those that can be relied upon to do so and without discomfort to the patient. For this reason I prefer the ones mentioned as made either by Messrs. Barth or Messrs. Coxeter. Of course, for syphilitic or tuberculous cases, it is better to employ metal facepieces, which can be more thoroughly sterilized by boiling. Facepieces can be had in all sizes suitable for adults or children.

The method of procedure is practically the same with all the closed varieties of apparatus. The patient is placed either recumbent or sitting up, but so that there is a free airway. Some say that it is not necessary to insert a prop between the teeth, but in case masseteric spasm might occur, it is desirable to do so, as well as to have a mouth wedge handy, in case the prop slips and trismus takes place. The face-piece is then placed over the patient's mouth, and he is told to close his eyes and breathe quietly. He then inflates the bag himself, if oxygen or oxygen and carbon dioxide is not used in lieu of the patient's expirations. Then a little ethyl chloride is squirted or introduced in one of the many ways into the bag. The quantity required will depend upon the type of subject, about 2 c.c. for children and up to 6 c.c. for adults. If the anæsthetic is introduced by degrees, the effect is not too unpleasant and struggling may be avoided. For children I usually anoint the prop with sugar and chocolate, the sucking of which hides the taste of the anæsthetic, and they are often under before they realize that the sweet is a mask to something not as nice. In nervous patients there may be some breath-holding, but not as a rule, if the initial dose is weak, then the breathing becomes deeper, more regular, and finally

stertorous. The face becomes flushed, the eyeballs roll and become fixed. Usually the pupils dilate, and finally the corneal reflex disappears. For short cases the facepiece can be removed prior to the abolition of the corneal reflex. If there is struggling, followed by deep breathing, care is needed to avoid the danger of an overdose. The effects usually come on with remarkable rapidity, consciousness being lost often in less than sixty seconds. The respiratory phenomena are the best guides as to the need of admitting additional air. If the bag at the beginning is full of air such may not be required, any cyanosis, or even distinctly stertorous breathing, is an indication to either stop the anæsthetic, or if a long anæsthesia is desired to admit a breath or two of air. Temporary respiratory embarrassment from spasm is not uncommon, and calls for a breath of air, followed when breathing becomes regular, but not before, by further re-breathing, and if required more anæsthetic. Ethyl chloride anæsthesia is apt to deepen after the cessation of the administration, as a result of the continued absorption of the vapour from the lower air passages.

It is possible to give quite two to three minutes' anæsthesia, if such is desired. For dental cases, where perhaps only half that time is needed, the induction can be stopped prior to the abolition of the corneal reflex.

Should it be desired to prolong the anæsthesia, the inhaler charged with more anæsthetic can be reapplied. It is, of course, very fugacious in action and the restoration to consciousness is rapid. It is essential to recollect that the narcosis, while it lasts, is deep and that the throat reflex is probably in abeyance; thus operations in which hæmorrhage may take place in the mouth may prove dangerous from passage of blood into the air passage, unless care be taken to maintain an airway, and to direct the flow of blood out of the mouth.

The so-called open method can be carried out with a Skinner's or a Schimmelbusch mask. One layer of flannel or eight of gauze is used. To ensure the close adaptation to the face, and so that inspired air is not drawn in at the side of the mask, instead of through the covering, a piece of gamgee, or spongiopiline, with a hole for the mouth and nose, is first applied. The mask is placed on top of this. The value of spongiopiline for this purpose is that it is soft, makes a good joint, and can be sterilized by boiling and repeatedly used. Ethyl chloride is sprayed on the covered mask, over the part above the mouth. After one breath or so, and when the patient gets used to the garlic-like odour, free air entrance and exit is further blocked by covering the mask with a layer

or two of towel. One, having a central opening of about half an inch round is most suitable. Further ethyl chloride is then sprayed on as necessary. When more breathing is deemed requisite the opening in the towel can be partially blocked by the hand. There must, of course, always be sufficient air to avoid any cyanosis. Induction takes place in about one and a half to two minutes, 8 to 12 c.c. of the anæsthetic is the average amount needed. Another way, permitting easier air blocking, and simpler in obtaining a gas-tight joint with the face, is to use an ordinary gas face-piece, such as those made by Barth or Coxeter, the pneumatic pad facilitates the making of a gas-tight joint between it and the face. The hole is covered by two layers of lint, and the ethyl chloride is sprayed on it. In using this means, 1 c.c. can be sprayed inside the face-piece prior to its application. It is then quickly put on. More ethyl chloride is sprayed on the lint over the hole, the air intake being restricted as deemed fit by the fingers. Induction in this way is also under two minutes. Sufficient air is admitted through the lint to maintain a perfect colour, the vapour tension in the atmosphere presented to the patient is also thus rendered sufficiently high to produce the desired effect, especially as re-breathing can be partially produced by covering the lint more or less with the fingers. Practice rapidly teaches the period for this partial covering, and the length of time for which it should be done.

At one time the open method employed, was, if I may so put it, TOO OPEN. The mask was held near, but not touching, the face for the first few breaths then it was applied without any other covering. To smother it over with, say a blanket, or even the mattress, is, of course, equally too much, as not employing another covering is correspondingly too little. As in all things there is a happy medium. I think that this explains the objections of some to the open method, or so-called "open method," as thus realized. On account of insufficient concentration struggling was more often marked than anæsthesia. Truly, the wisdom of Solomon can be made to look like folly by the accident of failure.

In the open method of induction the symptoms obtained are the same as those described with the closed methods, and similarly, for short cases, the induction can be stopped on fixation of the eyeballs and prior to, when lifting the upper eyelid, and touching the lower, flinching is not obtained. This is of course the correct method of testing for reflex, actually touching the cornea with the finger being too unhealthy for the eye. Many ophthalmic surgeons have remarked that anæsthetists did in this way add to their

number of cases. For a long anæsthesia, the administration can be proceeded with until the breathing is stertorous and the pupils are dilated. Any respiratory hesitation, calling immediately for cessation of the anæsthetic, and then, if breathing does not proceed, instant action, such as artificial respiration.

To contrast the respective merits of the two methods. The closed economizes ethyl chloride, 2 to 5 c.c. being the amount used. Against this should be set the cost of an inhaler and bag, and what is much more, the trouble of thoroughly cleansing and sterilizing the bag after each anæsthetic. I wonder if this is always done? The open method is of course more expensive in anæsthetic, 5 to 15 c.c. being often required. Some allege that the closed method is not more dangerous, others think to the contrary. They state that most of the fatalities have occurred when it is so given. This, if correct, may be merely because the closed method is the one generally adopted. The so-called open method certainly does not require as much attention; providing sufficient covering is employed the results are satisfactory. Of course, you may argue from this that satisfaction is merely obtained when the closed method is approached. I admit this. Still to many the rebreathing into a bag is a repugnant idea, though the CO_2 thus taken is of value by stimulation of the respiratory centre. This is only so if the percentage of CO_2 is not allowed to exceed 10 per cent. nor the oxygen content fall below say 14 per cent.

Concerning the different stages of anæsthesia, it differs but little from other pulmonary anæsthetics. After a few breaths the analgesic or first stage sets in, then stertor and spasmodic action may follow, but this, the second stage, is frequently absent, and the third or complete anæsthetic one directly obtained. If the drug is then pushed further, the fourth stage or one of complete cessation of respiration, arrest of the heart's action and death will follow. Watching the patient as already mentioned and making use of the signs of depth given render such an end to all intents and purposes an impossibility.

The routine of filling the bag with oxygen, instead of using the patient's expiration, is said to further aid the elimination of the period of excitement and muscular spasm.

The signs of overdose may perhaps once more be emphasized in concluding this chapter. They are: Very widely dilated and fixed pupils; (2) open eyelids; (3) great pallor; (4) intermittent respirations or gasping for breath.

CHAPTER V

ACCIDENTS AND AFTER-EFFECTS—
RESPIRATORY ARREST AND
CIRCULATORY FAILURE

SOME members of the profession have suggested that the anæsthetic branch is rather monotonous. The administration of an anæsthetic may, however, provide thrills as profound as any at the Grand Guignol. I suggest that, with the experienced man, the dim spectres of respiratory arrests and circulatory failure should be exorcised before they can stare operator and anæsthetist in the face, and these incidents that might inject a few raisins of interest into the alleged tasteless dough of our existence be avoided. The Duke of Wellington said that successful generalship largely depended upon the ability to divine what was going on at the other side of the hill. With the periscope of experience and training, we should be able to divine what is likely to happen and prevent it prior to its taking place. The man at the anæsthetic helm, who has the chart of hidden snags and rocks in his mind, may perhaps claim as his motto :—

Ademtum tibi jam faxo omnen metum, In aurem ultram vis otiose utdormias (Terentius).

Ethyl chloride, as already stated, is safe if administered according to the principles previously mentioned. If attention is not paid to the provision of unembarrassed respiration, and the appearance of too deep an anæsthesia, the signs of which were reiterated at the conclusion of the last chapter, the limits of safety may readily be overstepped, and then thrills may arise. Firstly, such may follow over-dosage, that is be due to ethyl chloride toxæmia, or intercurrent asphyxia, due to respiratory embarrassment. Overdose, if the preliminary indications of such are watched for, cannot take place. Should the administrator be half asleep himself and fail to read what is so legibly written out by the patient, then if cessation of the anæsthetic be immediate and artificial respiration be performed at once, recovery should be rapid on account of the volatility of the drug, IF ONLY THE OVERDOSE IS DETECTED IN TIME. With children inversion may be done, introduction of a finger into the anus, and as stated, artificial respiration. The latter is, of course, more easily carried out with a pulmotor if one is at hand, and that in addition introduces oxygen.

Otherwise in addition to artificial respiration, an intratracheal tube can be passed and oxygen introduced directly into the lungs, perhaps if with carbon dioxide, say 20 per cent., the stimulation of the respiratory centre by the latter may help.

If only noticed in time, the stoppage of the anæsthetic and artificial respiration should be ample. If not and all the other points mentioned are without avail, the question of abdominal opening and heart massage remains. Lastly, of course, there is the story to be concocted for the coroner. I cannot assist the unfortunate administrator there ; I only know that careful watching should have avoided this ending. The removal from the blood and tissue cells of the excess of the drug, if undertaken in time, is always successful. Asphyxia may result from masseteric spasm, if as previously stated a mouth prop was put in prior to starting, there should be little difficulty in introducing air or oxygen. In case the prop might fall out, a wedge should always be at hand. One common cause of impeded breathing is a mechanical one, the result of the falling or pressing back of the tongue. The operator is occasionally responsible for the latter cause of anxiety on the anæsthetist's part. A fact that I have noticed is, directly anyone takes up anæsthetics, to proclaim the fact he affixes a tongue forceps to a conspicuous portion of his overall. More, with or without need, they all make use of this lethal weapon. When the tongue does fall or get pushed back it must be brought forward at once. This can be effected by levering. Levering seems satisfactory, and certainly more humane, than seizing, bruising and wounding the tongue with a piercing or crushing instrument. While the tongue is levered forward, the jaw should also be pushed upwards. Ethyl chloride may cause, like chloroform from overdose, respiratory paralysis, but the quantity of it needed to bring about such a condition is according to Embley nineteen times that of chloroform.

If given in excessive concentration, the excitability of the vagus produced may cause a sudden syncope ; removal of the anæsthetic and artificial respiration usually effect recovery.

Among other causes of respiratory embarrassment may be mentioned mechanical interference, due to foreign bodies, such as teeth or blood, dropping into the air passages ; bringing the head forward should dislodge them, if not tracheotomy may be required.

Young children occasionally stop breathing during the period of induction, this though alarming rarely is serious. Cessation of the anæsthetic, lowering of the head, chest compression and artificial respiration usually restore breathing at once.

With regard to the recovery. In most things, including

anæsthetics, it is the attention and observation of small details that ensure success, likewise prevent failure. Kismet does not come into the picture; as the natives of Uganda remark: "You can pray, 'God help me' only when you've put forth all your speed." It is no use asking the spirits to help you run if you do not mean to sprint. This comes to what I am afraid I have rather laboured throughout this brochure, the importance of the proper preparation of the patient and the need for keeping alert of the administrator. After all, nothing but good can be done by calling attention to possible, but avoidable perils, even if in placing these pictures on the canvas I have not avoided the trick of making the same point several times, and have even put on the paint very thickly.

As to the after-effects, it is interesting that patients often come to as they went under; a nervous hysterical woman will struggle as she goes under, probably she will commence struggling again as anæsthesia passes off; a child cries during the induction, and after the anæsthesia begins to pass off resumes the previous lamentations. A point that is at times noted is that headache, nausea and vomiting are rather frequent sequelæ. An empty stomach and a nicely adjusted anæsthesia help to obviate these after-effects. Headache may be often avoided if the patient is kept in the recumbent position for about half an hour after the operation.

Beyond the rather frequent occurrence of headache, giddiness and perhaps vomiting, the after effects may be taken as insignificant and not in any way severe. For minor operations the advantage is that the patient can almost always walk home afterwards. When used as a preliminary to ether the subsequent vomiting seems to occur in a similar percentage of cases as when the induction was conducted without it, and in these cases it seems that the ethyl chloride has little, if any, effect on the after-effects of the anæsthetic. The question of post-anæsthetic vomiting is, of course, one open to much diversity of opinion. Proper preparation, prevention of salivation by atrophine, a quiet induction, regularity of anæsthetic dose and depth will in most cases obviate it. With some patients when chloroform is used the subsequent vomiting due to acidosis may be very severe.

The subjects of operations on the throat and mouth, which are frequently attended by the swallowing of blood, are naturally sick as a consequence of the blood swallowed. Anæsthetists are frequently blamed for what is really an effect of the operation. Such treatment often makes me think of that famous picture of a standing wet umbrella, a pool of water, and a dog, who with much truth remarks, "I shall be credited with this." Whatever occurs it is put to the credit of the anæsthetist.

CHAPTER VI

METHODS FOR PROLONGED ADMINISTRATION
—ETHYL CHLORIDE AS AN INTRODUCTION
TO OTHER ANÆSTHETICS

THOUGH many anæsthetists do not favour the prolonged use of ethyl chloride, it is available for such purposes. The late Dr. Barton divided this class of case into those in which the anæsthetic can be given by the usual apparatus throughout, and those operations on the upper air passages in which a mask is inadmissible during the operation. In the first category induction is carried out in the usual way, generally pushing the anæsthetic, and only removing the mask when the stertorous breathing and dilated pupils gave evidence of an anæsthesia likely to last a full three minutes. The anæsthetic would then be continued at intervals, the breathing being taken as a guide; when it was deep and rapid the face-piece being removed and pressed firmly into the pillow to prevent waste from evaporation; when, after a few breaths of air the respirations approached the normal, the face-piece would be applied again for a few breaths, more anæsthetic being sprayed into the bag as needed. In some cases the alteration in the character of the respiration is not sufficiently marked to form a satisfactory guide. The corneal reflex has then to be relied upon, allowing it just to return in the intervals of administration and then just abolishing it again. With great attention and experience a fairly satisfactory prolonged anæsthesia can thus be obtained and maintained. Ether or chloroform is much more satisfactory, and there seems little advantage in employing ethyl chloride for such purposes.

The cardinal rule in all anæsthesia being a regular dose and a regular depth. Some with great experience can obtain this in this way, with much care, but it is neither easy to do, nor does there appear any advantage in so doing. The other class, mentioned by Dr. Barton, namely, operations in which the ordinary mask is inadmissible during operation, can be undertaken by continuing the administration through a tube, the ethyl chloride vapour being supplied from a metal con-

tainer, immersed in hot water, so as to ensure the giving off of the vapour needed. The conveying tube can be passed through the nostril delivering its contents at the back of the palate, or the tube can be attached to tubes affixed either to the gag employed or the mouth prop. Dr. Barton generally employed either a Doyen or Wingrave gag with such an attachment. Nowadays it could of course be used with the popular suspension, Davis Boyle gag. The induction in these cases is carried out in the usual manner, the patient being got well under, as shown by the presence of deep, snoring breathing, and absence of corneal reflex. To save delay in affixing the tube after induction, the Doyen or Wingrave gag is put in previously, and a deep face-piece is used, which allows of a good joint, with the face, though the gag is in. The Davis Boyle gag naturally cannot be put in before the patient is fully under. The rubber tube from the ethyl chloride container is then affixed to the gag, and the anæsthetic so continued, a screw on the top of the container allowing of the regulation of the flow of the vapour. In spite of the amount of air obtaining entrance at the same time, in most cases, with a deep induction, anæsthesia can be continued.

The waste of time that occurs to introduce the Davis Boyle gag does render its employment in that way rather difficult. In three cases so attempted, ether had to be substituted for continuing the anæsthesia in two. Bubbling warm oxygen vapour through ethyl chloride was also tried, for maintenance of the anæsthesia. It did not present any features to commend its employment in that way.

To sum up, the employment of ethyl chloride alone for long operations does not seem an advantage nor especially suitable, especially as the uniformity of the resulting anæsthesia is at best but an "up and down" one, and removed in varying degrees, but certainly removed from the level anæsthesia at which one should always aim. Still it can in an emergency be used, though I advance that it should not be employed if other means are available.

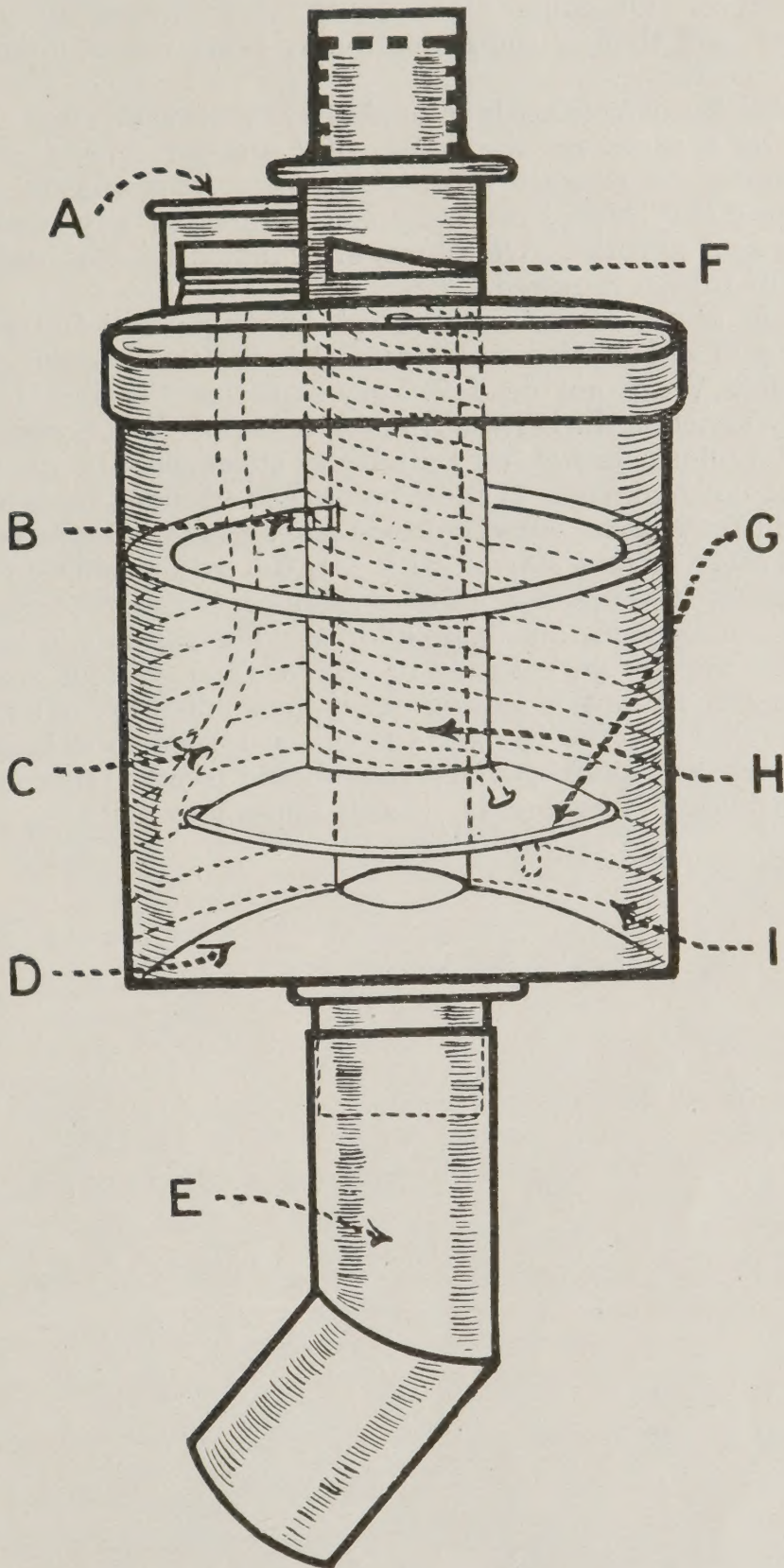
Ethyl chloride is a most valuable agent for the induction of anæsthesia before passing on to another anæsthetic. The sequence that I deem the most suitable is ethyl chloride—ether.

It certainly makes a very pleasant induction, and as previously remarked, its rapidity curtailing what to most is an uncomfortable and distressing period, the time from the commencement of administration until unconsciousness takes place. The crux of this induction lies in getting a sufficient concentration of ether vapour into the patient before the effects of the ethyl chloride have passed off.

Using the Clover inhaler, the bag is first distended with the patient's expirations or what is preferable with oxygen, 2 to 3 c.c. of ethyl chloride is then squirted in through the aperture provided for that purpose, and re-breathing proceeded with, the ether being simultaneously slightly turned on. In so doing, it should be gradually increased, feeling your way, diminishing or increasing the proportion according to the manner the patient takes it. If the correct percentage is used, and at the right time, the struggling stage is eliminated, cyanosis is absent, and a quiet, peaceful, happy induction is obtained. The same can be had with the open method. Spongiopiline is used to obtain a good joint between the mask and the face. The latter should be covered with eight layers of gauze. Ether and ethyl chloride are simultaneously poured on, air restriction being partially employed by means of a towel; as induction occurs, the ethyl chloride is discontinued, and ether only dropped on the mask, air admission being restricted by the hand, and thus partial rebreathing promoted. In both methods a mouth prop should be put in prior to commencing, and after induction an air way. The maintenance of anæsthesia is then best continued by bubbling oxygen through ether, and conveying it to an attachment at the side of the air way. Messrs. Coxeter manufacture a chloroform and ether apparatus, in which the oxygen can be blown over or through either the ether or chloroform, and the percentages thus altered. A radiator type of warming apparatus immersed in a thermos jar permits of heating the vapour. Messrs. Barth and Messrs. Coxeter both manufacture the special airways with side attachment mentioned.

In children the employment of a mouth prop covered with chocolate frequently eliminates lamentations. For these I generally use my chloroform percentage inhaler, charging it, however, with ether, opening the indicator to full, and directly after it is applied spraying ethyl chloride on a gauze-covered frame placed over the air tube.

The ethyl chloride—chloroform sequence is favoured by many. Dr. Hadfield writes advising it and so did the late Dr. Barton. Ethyl chloride is used for the induction in the usual manner, and after the breathing becomes automatic chloroform is substituted. Thus a rapid induction is obtained. In passing over rapidly to chloroform, there may be a period of quiet breathing coupled with a dilated pupil. The question then arises: Is this state one of chloroform overdose, or is it the result of the ethyl chloride? Spasm of the jaw, as Dr. Barton pointed out, should incline to the conclusion that the symptoms are the result of the ethyl chloride, and not to chloroform



Percentage chloroform inhaler.

over-dose. Of course if in doubt, it is wisest to play for safety, and though the patients may come round, discontinue the anæsthetic.

With the percentage inhaler already mentioned, ethyl chloride can be sprayed on the frame over the air tube, and if the apparatus be charged with chloroform, that anæsthetic can be gradually given, the indicator permitting any percentage from zero to three. Of course, after induction, the frame over the air tube is removed.

This sequence in experienced hands is satisfactory, but care and observation are essential if the thrills mentioned in Chapter V are not desired. My experience is that they are likely to occur, during the transition period, if the percentage of chloroform is not very gradually advanced, and the gauze frame not removed. If these points are attended to, it is ideal. The nitrous oxide—ethyl chloride sequence, this may be resorted to if, after having started with gas, the patient shows signs of not taking it well, but it is also of value to get a longer anæsthesia than ordinary nitrous oxide affords. The gas should be given in the usual way, with air or oxygen, and without cyanosis ; when the patient is getting under, 3 c.c. of ethyl chloride are introduced into the bag and the valves turned to re-breathing. The use of nasal gas oxygen should render this method superfluous. I cannot say that it appeals to me.

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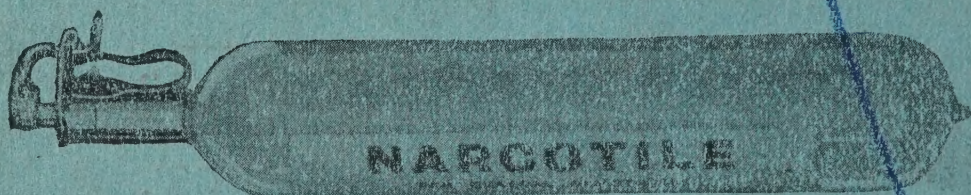
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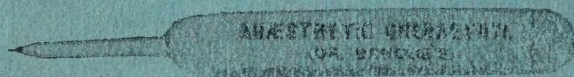
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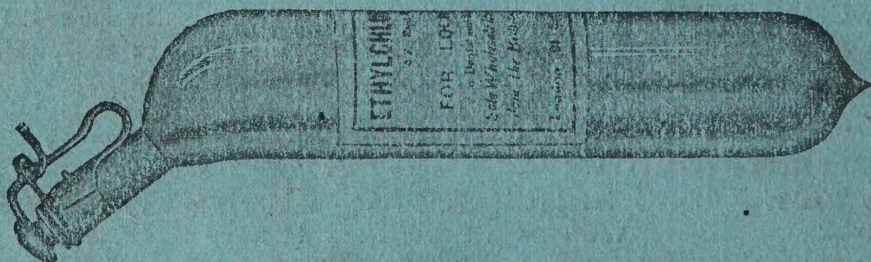
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